IEC/IEEE 60802

Bridged end station model

Requirements and assigned features

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Requirements

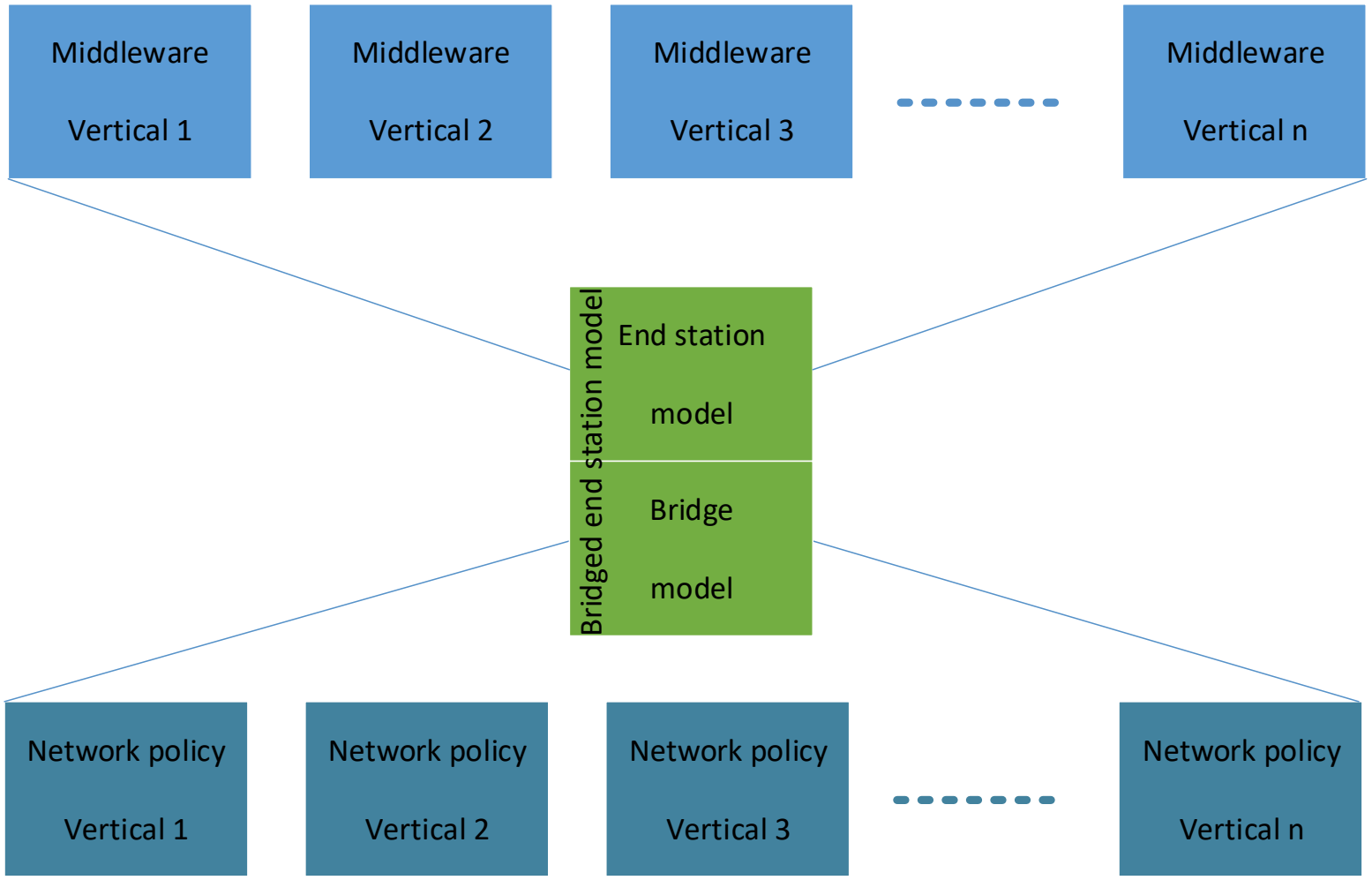
A bridged end station is a very common solution in industrial automation.

It’s often an optimized version of a end station and a bridge build into one housing.

The soldered down well-known interface between end station and bridge are often optimized to reduce the latency.

Industrial automation bridged end stations, similar to industrial automation end stations, are used as one hardware basis in many verticals.

Principle


Middleware
Vertical 1
Middleware
Vertical 2
Middleware
Vertical 3
Middleware
Vertical n
Bridged end station model
End station
model
Bridge
model
Network policy
Vertical 1
Network policy
Vertical 2
Network policy
Vertical 3
Network policy
Vertical n

General Requirements

End stations implementing industrial communication protocols are often able to consume the whole bandwidth available at the Ethernet interface.

Thus, disciplining the network access to limit the bandwidth usage is required to avoid immediate frame dropping at the first bridge.

Additionally, knowing about the disciplined interfaces supports the network calculus of a Digital Twin.

These requirements apply for the bridged end station, too.

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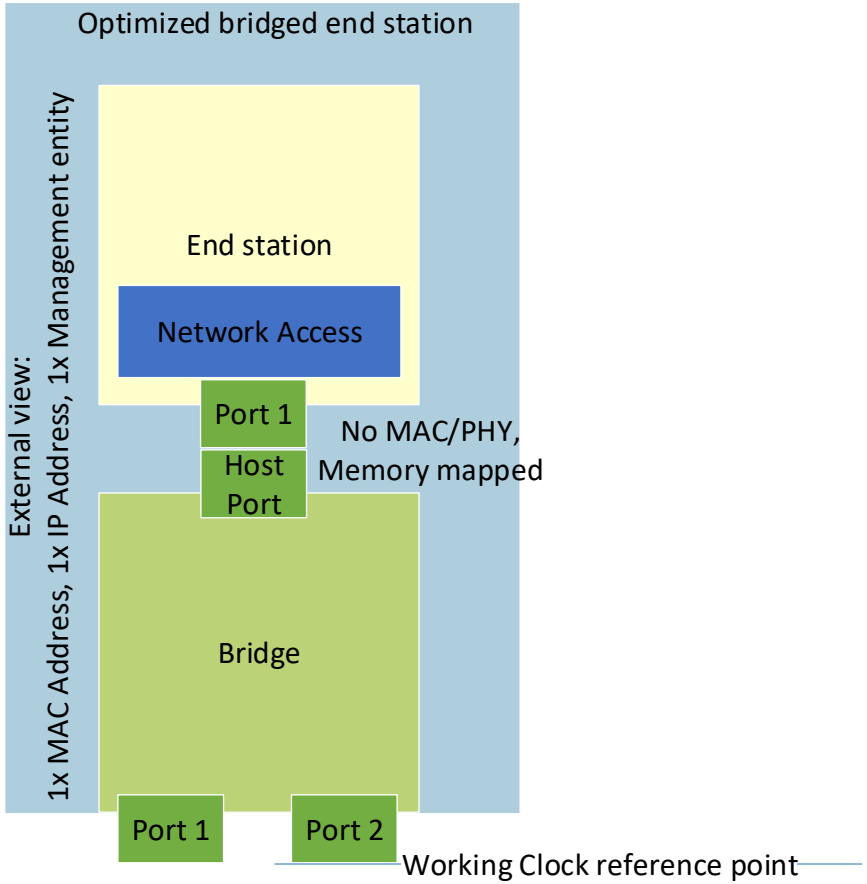
Definition

Problem statement

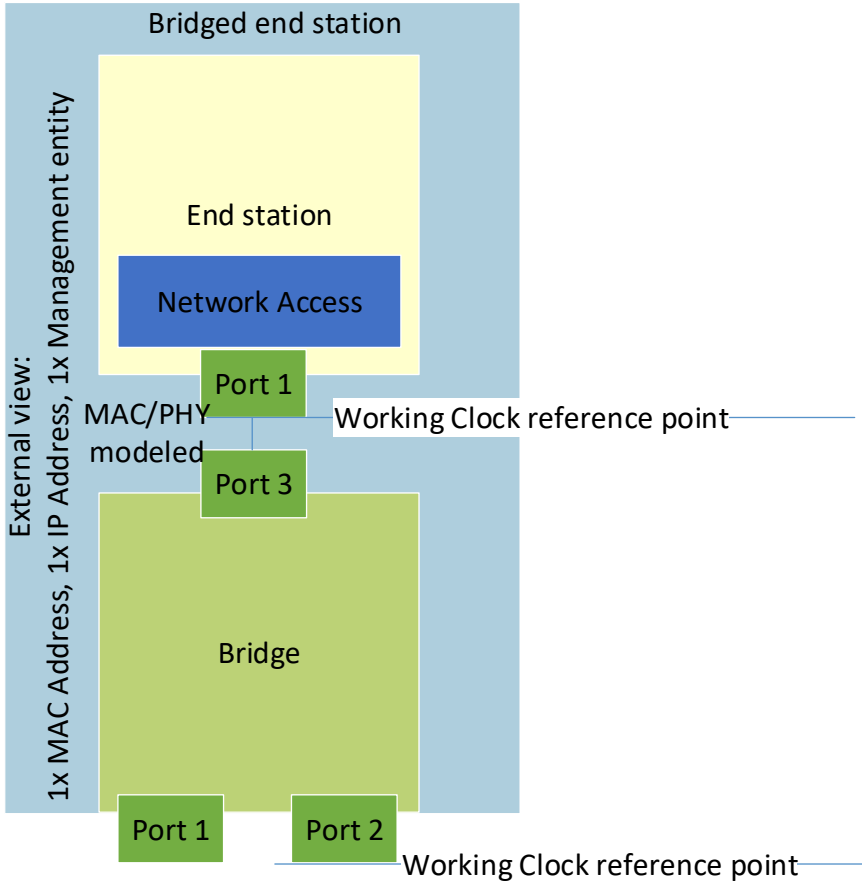


Todays bridged end stations are often implemented with a memory mapped proprietary interface between network access and bridge.

This allows optimizations, e.g. injecting traffic directly to the external port, even in case of per frame time triggered transmit.

How can this model be moved to the IEEE 802 bridge and end station configuration model?

Suggested solution



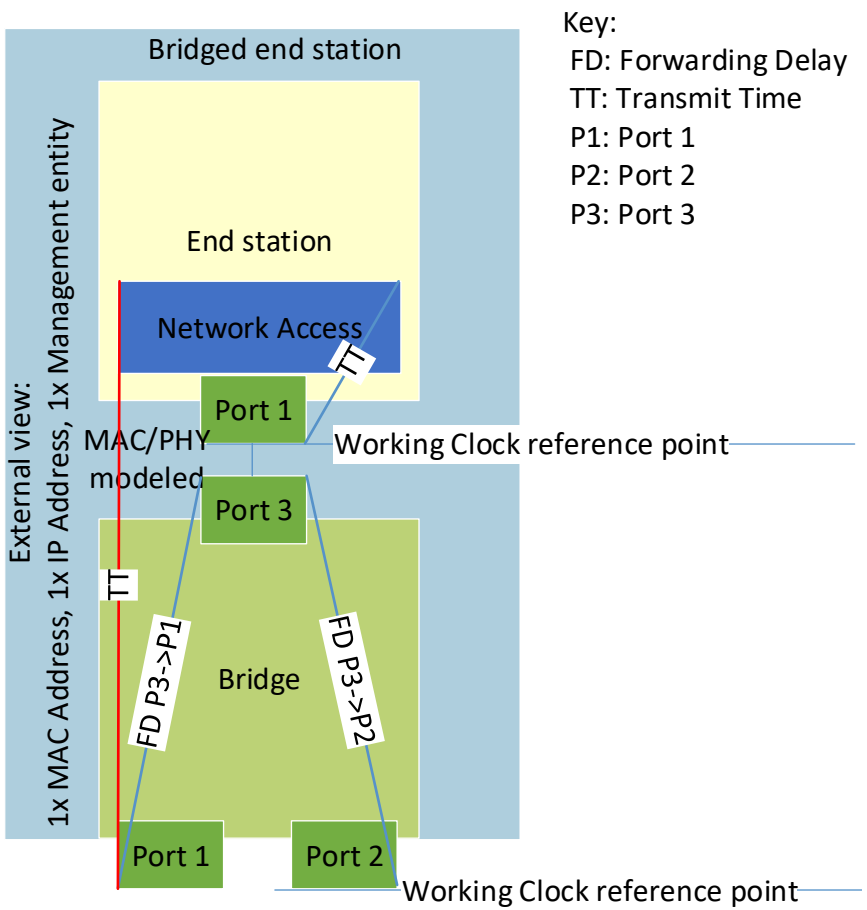
Bridged end station is modeled as a housing containing both end station and bridge.

From the customers point of view the addressing requirements, one address per box, are still valid.

IEEE 802 model based configuration should be possible.

How can we integrate both entities in e.g. LLDP or PTP as one physical entity?

Optimization

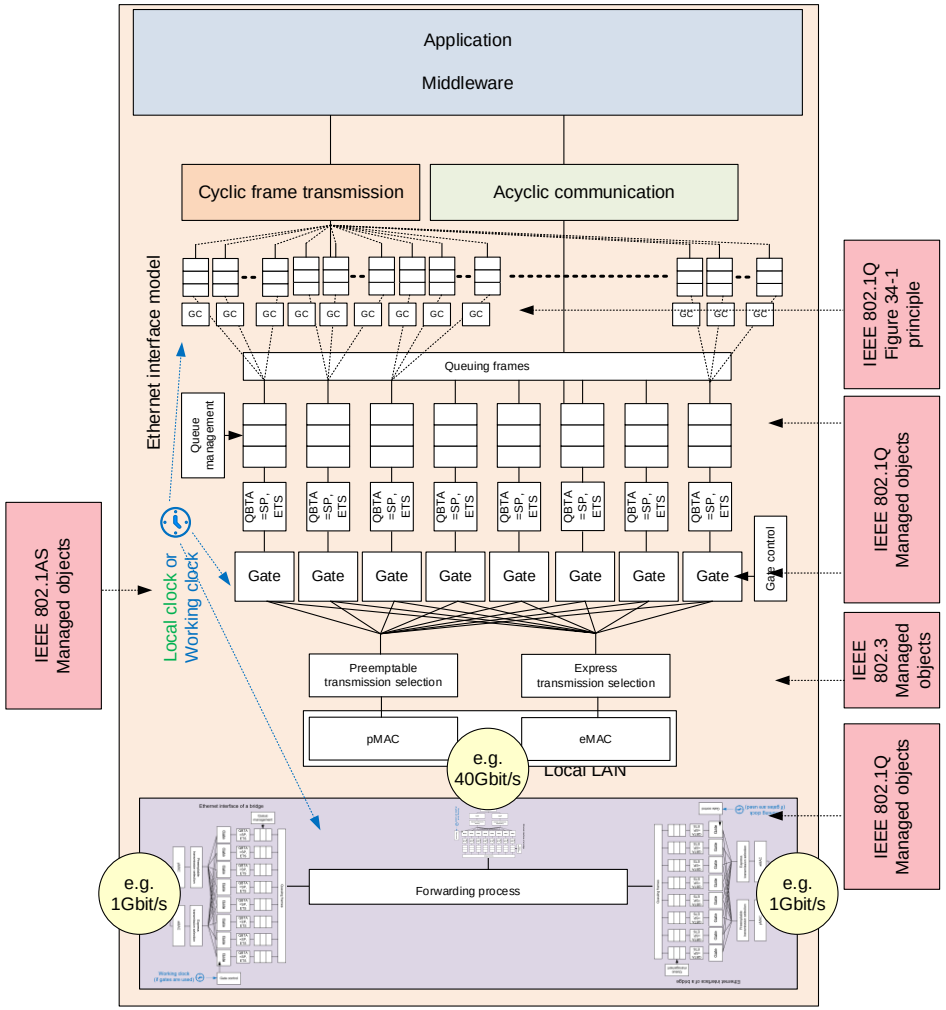


This model may be optimized in the following way:

1. Define link delay between end station port and bridge port as zero
2. Define forwarding delay between bridge port 3 and bridge port 1 or bridge port 2 as zero
3. Define transmit time from network access to bridge port 1 or 2 to cover all to be covered latencies
4. Make sure that the real end station to bridge interface is powerful enough to use both external bridge ports concurrently

Transmit direction

Bridged end station model



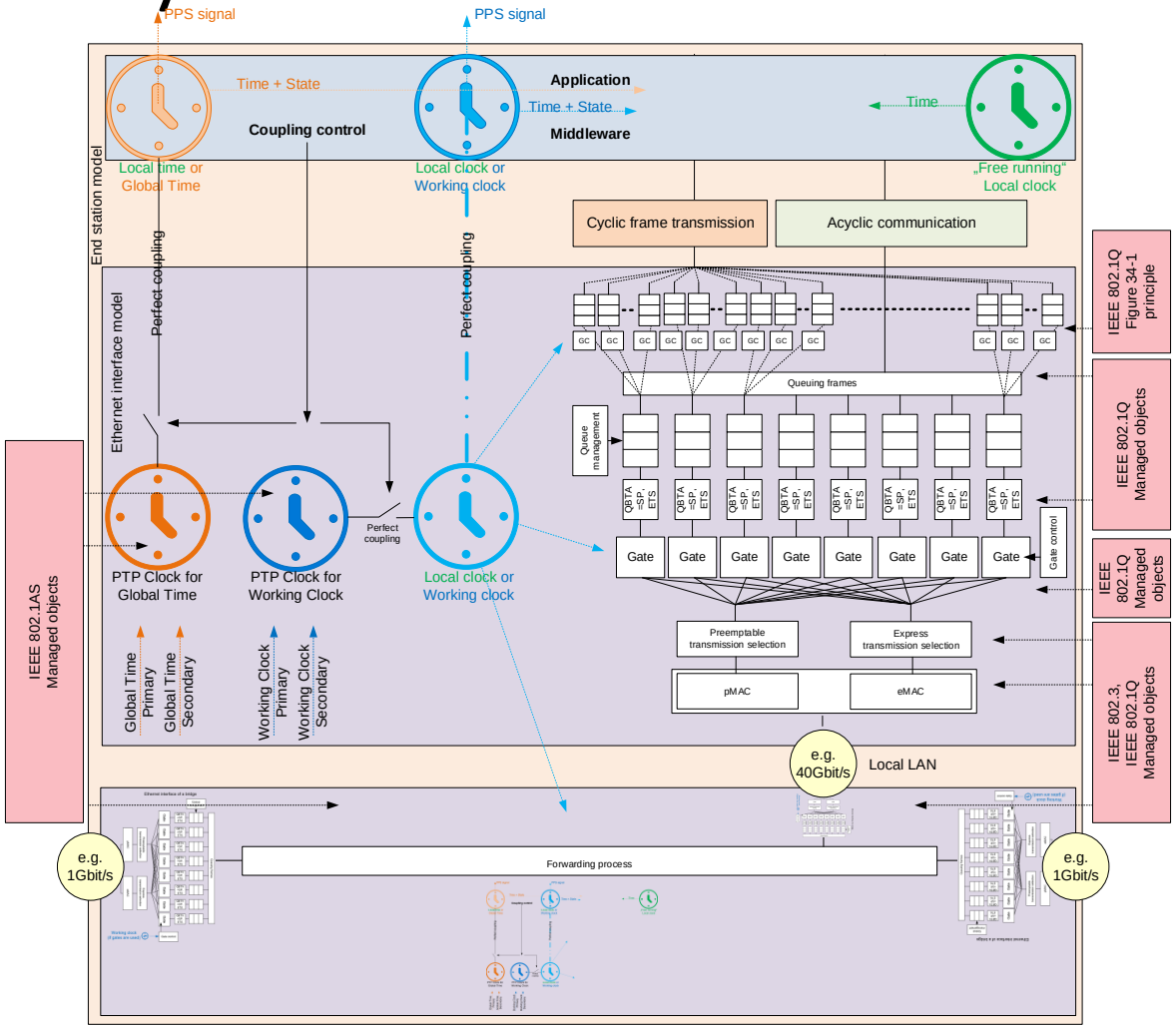
The model of a bridged end station need to cover the end station ability to make concurrent use of all available bridge ports at wire speed.

That could be done by specifying a much higher bandwidth at the interface between bridge and end station.

Due to this optimization, neither pre-emption nor time aware shaping is used at this internal bridge port.

Synchronization model

Bridged end station model including synchronization



The brdiged end station model needs to include synchronization.

Working Clock is used by bridge, end station interface, and end station.

Global Time is used by the end station.

Application requires availability of Global Time and Working Clock at all times and thus, the end station maintains two instances of Working Clock and Global Time.

The coupling of these two instances is controlled by the application.

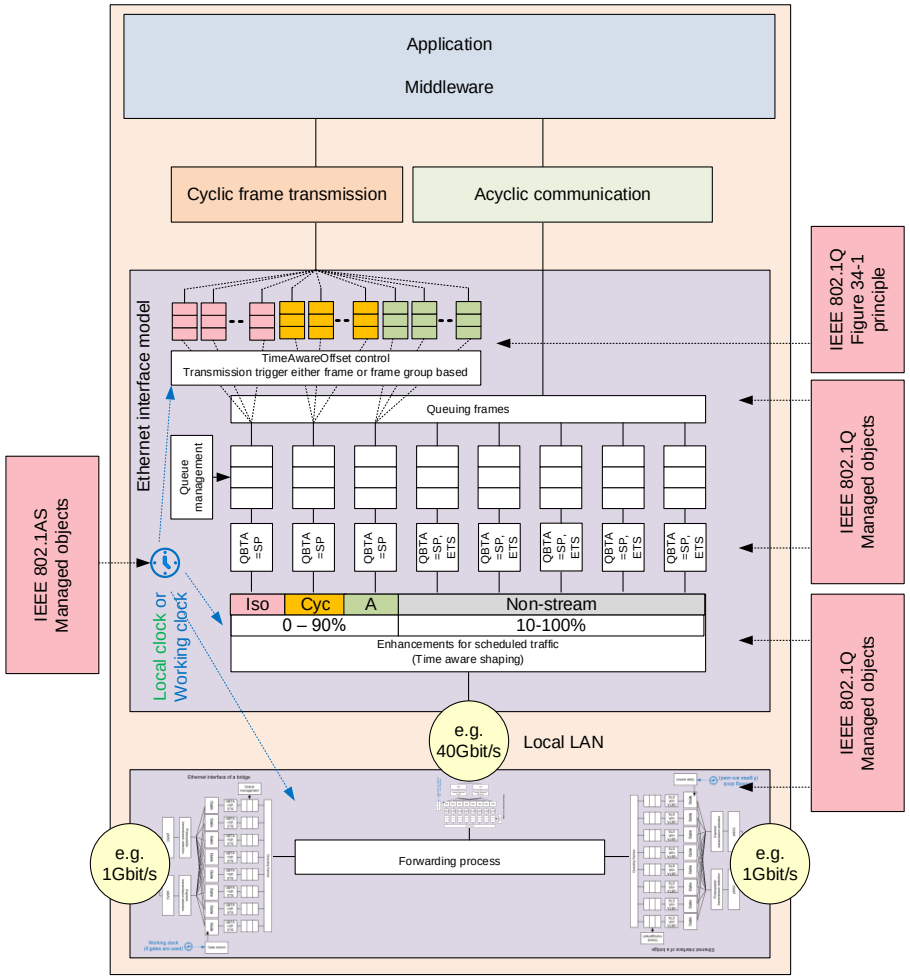
Working Clock timescale is assumed as ARB.

Global Time timescale is assumed as PTP.

Additionally, (just for information) the application uses a free running local clock which make sure that even smallest timespans are only influenced by the oscillator quality.

Example

Bridged end station model

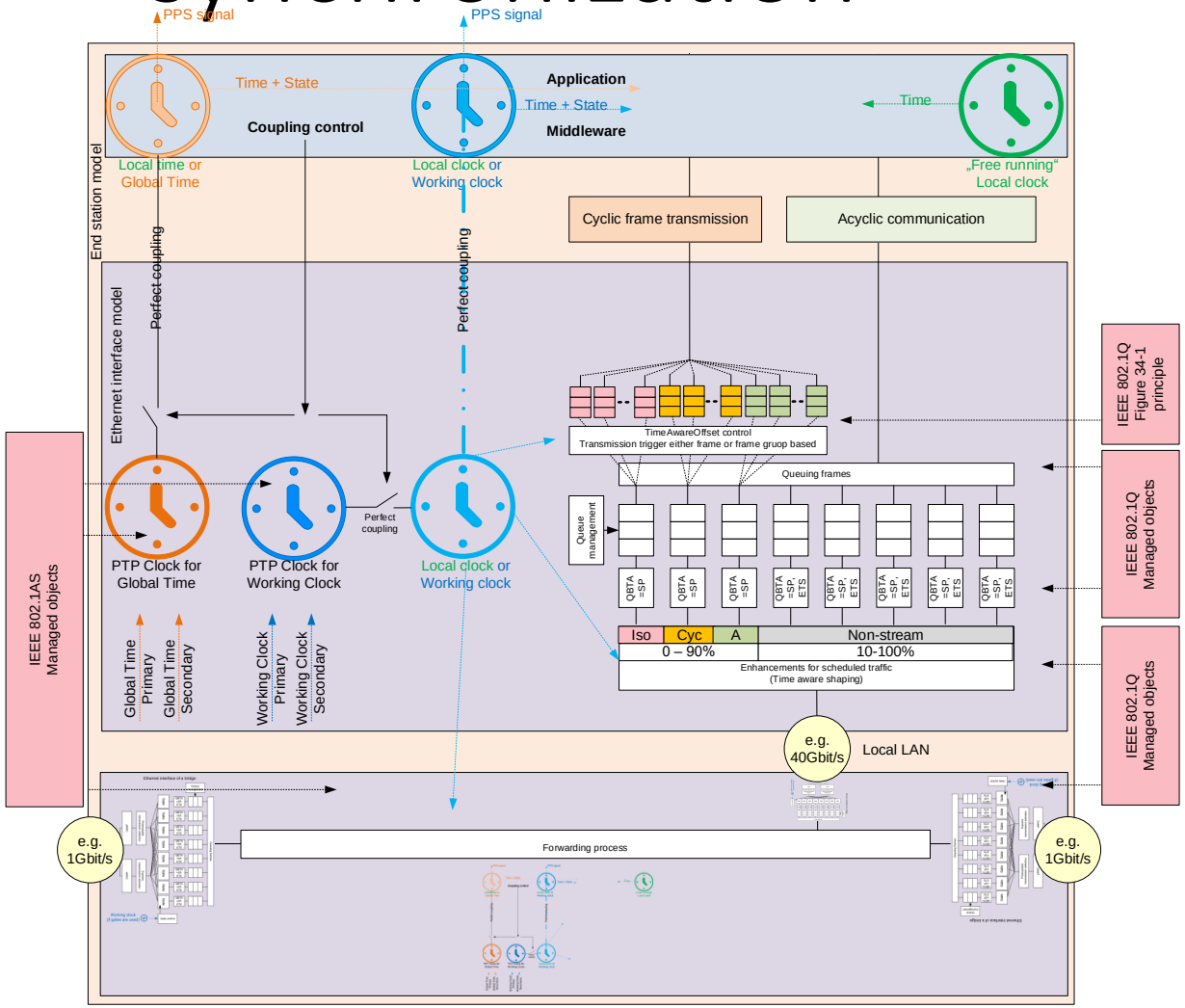


The end station portion uses three stream traffic classes and five non-stream traffic classes.

The bridge portion will be configured in multiple modes.

With or without Enhancements for scheduled traffic depending on the needs of the application.

Bridged end station model including synchronization



Application is relying on the availability of Working Clock and Global Time provided by the end station portion.

The bridge portion is either PTP relay or PTP relay and PTP end instance depending on the used configuration.

Optimization:

One PTP end instance controls the Working Clock of both, end station interface and bridge.

Conclusion

Proposal

- Specify a bridged end station model covering requirements from many industrial automation verticals
- Functionalities of this model may be stated optional, but shall be specified in detail in the 60802
- Configuration of a Bridged End Station should be as if a bridge and an end station were installed in only one housing
- Configuration of shown managed objects of the bridged end station is done by network management of the TSN domain
- The end station and the bridge model are used close to unchanged

Questions ?